Action functional

$$
\begin{aligned}
S_R &= \psi^\dagger \Big[-Z_1 \partial_t - Z_4 (\boldsymbol{v}\cdot\boldsymbol{\nabla}) - a Z_5 (\boldsymbol{\nabla}\cdot\boldsymbol{v}) + Z_2 D \nabla^2 - Z_3 D\tau \Big] \psi + \\
&+ \frac{D\lambda}{2} [Z_6 (\psi^\dagger)^2 \psi - Z_7 \psi^\dagger \psi^2] + Z_8 \frac{u_2}{2D} \psi^\dagger \psi \boldsymbol{v}^2 - \frac{\boldsymbol{v} D_v^{-1} \boldsymbol{v}}{2}
\end{aligned}
$$

Renormalization constants

We have used the following redefinition of charges g_1 and g_2

$$\frac{g_1}{16\pi^2} \to g_1, \quad \frac{g_2}{16\pi^2} \to g_2$$

and we have set $d = 4$ wherever possible

$$
\begin{aligned}
Z_1 &= 1 + \frac{g_1 \alpha a(1-a)}{(1+u_1)^2 y} + \frac{g_2}{4\epsilon}, \\
Z_2 &= 1 - \frac{g_1}{4(1+u_1)y} \left[3 + \alpha \left(1 - \frac{2}{1+u_1} - \frac{4a(1-a)u_1}{(1+u_1)^2} \right) \right] + \frac{g_2}{8\epsilon}, \\
Z_3 &= 1 + \frac{g_1 \alpha a(1-a)}{(1+u_1)^2 y} + \frac{g_2}{2\epsilon}, \\
Z_4 &= 1 + \frac{g_1}{4(1+u_1)^2 y} \left[\alpha \left(1 + \frac{4a(1-a)u_1}{1+u_1} \right) - u_2(6 + 6u_1 + 2\alpha u_1) \right] + \frac{g_2}{4\epsilon}, \\
Z_5 &= 1 + \frac{g_1 \alpha}{4(1+u_1)^2 y} \left[1 + 2(1-a) \left(2a - \frac{1}{1+u_1} \right) \right] - \frac{g_1 u_2}{4a(1+u_1)y} \left[3 + \alpha - \frac{2\alpha(1-a)}{1+u_1} \right] + \\
&\quad \frac{g_2(4a-1)}{8a\epsilon}, \\
Z_6 &= 1 - \frac{g_1 \alpha (1-a)}{(1+u_1)y} \left[1 - a - \frac{2a}{1+u_1} \right] + \frac{g_2}{\epsilon}, \\
Z_7 &= 1 - \frac{g_1 \alpha a}{(1+u_1)y} \left[a - \frac{2(1-a)}{1+u_1} \right] + \frac{g_2}{\epsilon}, \\
Z_8 &= 1 + \frac{g_1}{2(1+u_1)y} \left[\alpha \frac{2a(1-a)+1}{1+u_1} - \frac{\alpha a(1-a)}{u_2(1+u_1)^2} - u_2(3+\alpha) \right] + \frac{g_2}{2\epsilon},
\end{aligned}
$$

Relations between renormalization constants

$$Z_1 = Z_\psi Z_{\psi^\dagger},$$

$$Z_2 = Z_\psi Z_{\psi^\dagger},$$

$$Z_3 = Z_\psi Z_{\psi^\dagger} Z_D Z_\tau,$$

$$Z_4 = Z_\psi Z_{\psi^\dagger} Z_v,$$

$$Z_5 = Z_\psi Z_{\psi^\dagger} Z_v Z_a,$$

$$Z_6 = Z_\psi Z_{\psi^\dagger}^2 Z_D Z_\tau,$$

$$Z_7 = Z_\psi^2 Z_{\psi^\dagger} Z_D Z_\lambda,$$

$$Z_8 = Z_\psi Z_{\psi^\dagger} Z_v^2 Z_{u_2} Z_D^{-1},$$

$$1 = Z_{u_1} Z_D,$$

$$1 = Z_{u_1} Z_{g_1} Z_D^3 Z_v^{-2},$$

$$Z_D = Z_2 Z_1^{-1},$$

$$Z_\tau = Z_3 Z_2^{-1},$$

$$Z_v = Z_4 Z_1^{-1},$$

$$Z_a = Z_5 Z_4^{-1},$$

$$Z_\psi = Z_1^{1/2} Z_6^{-1/2} Z_7^{1/2},$$

$$Z_{\psi^\dagger} = Z_1^{1/2} Z_6^{1/2} Z_7^{-1/2},$$

$$Z_{u_1} = Z_1 Z_2^{-1},$$

$$Z_\lambda = Z_1^{-1/2} Z_2^{-1} Z_6^{1/2} Z_7^{1/2},$$

$$Z_{g_2} = Z_1^{-1} Z_2^{-2} Z_6 Z_7,$$

$$Z_{u_2} = Z_2 Z_8 Z_4^{-2},$$

$$Z_{g_1} = Z_2^{-2} Z_4^2,$$

Anomalous dimensions

$$
\begin{aligned}
\gamma_D &= -\gamma_1 + \gamma_2, \\
\gamma_a &= -\gamma_4 + \gamma_5, \\
\gamma_{u_2} &= \gamma_2 - 2\gamma_4 + \gamma_8, \\
\gamma_{g_2} &= -\gamma_1 - 2\gamma_2 + \gamma_6 + \gamma_7, \\
\gamma_v &= -\gamma_1 + \gamma_4
\end{aligned}
$$

$$
\begin{aligned}
\gamma_D &= \frac{g_1}{4(1+u_1)}\left[3 + \alpha\frac{u_1 - 1}{u_1 + 1} + \frac{4\alpha a(1-a)}{(1+u_1)^2}\right] + \frac{g_2}{8}, \\
\gamma_a &= (1-2a)\left[\frac{g_1\alpha(1-a)}{2(1+u_1)^3} + \frac{g_1 u_2}{4a(1+u_1)}\left(3 + \alpha - \frac{2\alpha}{1+u_1}\right) + \frac{g_2}{8a}\right], \\
\gamma_{u_2} &= \frac{g_1(1-2u_2)}{4(1+u_1)}\left[3 + \alpha\frac{u_1 - 1}{u_1 + 1} + \frac{2\alpha a(1-a)}{u_2(1+u_1)^2}\right] - \frac{g_2}{8}, \\
\gamma_{g_2} &= -\frac{3g_1}{2(1+u_1)} + \frac{g_1\alpha}{1+u_1}\left[\frac{(1-2a)^2}{2} + \frac{1-3a(1-a)}{1+u_1} + \frac{2a(1-a)u_1}{(1+u_1)^2}\right] - \frac{3g_2}{2}, \\
\gamma_v &= \frac{g_1\alpha}{4(1+u_1)^2}\left[\frac{4a(1-a)}{1+u_1} - 1\right] + \frac{g_1 u_2}{2(1+u_1)}\left[3 + \frac{\alpha u_1}{1+u_1}\right].
\end{aligned}
$$